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ENERGY

FRENCH, NORWEGIANS STUDY ATOMIC-POWERED HYDROGEN PRODUCTION

Bonn DIE WELT in German 5 Sep 80 Welt Report Supplement pp 36-39

[Article by Anton Ziechka, energy futurologist: "The Element of the Future"]

> [Text] The salvation of the human race lies in the hydrogen economy. The hydrogen economy alone can avoid disaster.

If today's world is struggling under an existential crisis, it is not because of the lack of energy, but because today's most important energy source, oil, is diminishing, and adapting to the post-oil age signifies the greatest change of the economic system of all times.

Just as in the past coal replaced wood, because too many forests were depleted, so oil, sold at bargain prices for generations, has to be replaced by other energy sources. This must take place now and not in the next century, and, therefore, nuclear energy will play a main part in this substitution.

But, of course, not nuclear energy alone. Nuclear energy has to supply the electric energy which coal alone cannot supply. It has to supply the process for hydrogenetion and gasification of coal, because otherwise four-tenths more coal would have to be used for the same amount of hydrogenation-process gasoline and synthesis gas.

Nuclear energy has to supply the power for complete electrification of the railroads and for the electric automobiles of tomorrow. It has to supply the heat for melting processes in steel, ceramic and glass furnaces, which use oil today. But above all, it has to supply electricity. Electricity which is used in huge amounts for water electrolysis, because only hydrogen from electrolysis can replace the hydrogen obtained from natural gas and crude oil.

Thus, the post-oil age will be founded on a nuclear energy hydrogen combination and on a hydrogen economy instead of the present hydrocarbon economy. And with this, Jules Verne's answer in "The Mysterious Island" given in 1874 to an engineer's question what man will burn after depletion of fossil fuel: "Water!" will come true. "Water consists of hydrogen and oxygen and these elements are an inexhaustible source of heat and light."

Hydrogen is the element found most abundantly in the universe. The same volume hydrogen contains three times as much energy as natural gas, the same weight two and a half times as much energy as gasoline. Hydrogen burns to form pure water, and therefore, is the environmentally safest of all energy sources. Hydrogen

forms two thirds of all water and since the sun is responsible for the water cycle of the earth, hydrogen, like waterpower, means energy renewed eternally. Hydrogen economy means living off the interest instead of using up capital as in the hydrocarbon economy.

However, hydrogen in its free form occurs only rarely in nature. For the production of this energy source large amounts of energy have to be invested. This energy is now available in the form of nuclear energy, and nuclear energy and hydrogen complement each other perfectly: nuclear power plants are suited especially well for base-load power production. They produce the same amount of power throughout the year and are difficult to adjust to seasonally and daily fluctuating requirements. Therefore, low-cost surplus power is available, which can be used for water electrolysis. Nuclear power plants can store large amounts of electricity in the form of hydrogen and can supply peak current with gas turbines or can produce hydrogen for other purposes.

This will occur in France very soon as a result of the 1977 agreement of collaboration between Electricite de France and Norsk Hydro in Oslo, a large-scale enterprise, which has produced hydrogen by electrolysis for half a century. Since 1927 Norsk Hydro has produced ammonia from electrolytic hydrogen and nitrogen gained through air liquefaction. With occasionally 100,000 and now 55,000 cubic meters of hydrogen per hour, the plants in Rjukan and Glomford are the biggest in the world.

Norsk Hydro was and still is leading in the improvement of the efficiency of electrolytic hydrogen production (also involved are other companies, Brown, Boverie & Cie., for instance, which are now developing a new generation of water electrolyzers). In Oslo this efficiency has been increased from about 60 percent to approximately 80 percent in 1980, that means, with the same amount of energy four-tenths more hydrogen has been gained.

The research in the laboratories of Heroya and Notodden continues. It is concentrated on a special coating of the electrodes, which promises a further improvement in efficiency of 7 to 8 percent.

The national French electricity-supply company performs experiments in its laboratories for Norsk Hydro and tests the new Norwegian developments. To obtain exact figures on the economic efficiency of nuclear power for hydrogen production a large-scale experimental plant has been planned for 1983.

In 1990 France expects to produce 420 terawatt hours (420 billion kilowatt hours) from its (by then) 45 nuclear power plants and approximately 620 TWh nuclear energy by the year 2000. This is almost double the FRG's total power consumption today. "Surplus-power" of 10 to 30 billion kWh is expected yearly. This would result in 3.3 to 10 billion cubic meters of hydrogen, equalling 10 to 30 billion cubic meters of natural gas. That would be approximately 300,000 to 900,000 tons of hydrogen, equalling 750,000 to 2.25 million tons of gasoline. This, of course, is not sufficient for the substitution of oil. But already, nuclear power stations used solely for hydrogen production are being contemplated.

The main advantages of a hydrogen economy are: Hydrogen is a fully synthetic product produced from water. Water is a basic substance and inexhaustible. It is present practically everywhere on earth and cannot be monopolized.

Hydrogen is the cleanest of all fuels, because its product of combustion is steam. Neither carbon dioxyde--a too-great concentration of which in the atmosphere could cause climate changes--nor hydrogen sulphide or soot are formed. Furthermore, considerably less nitric oxides are formed than by the combustion of fossil fuels.

Steam as the product of combustion returns immediately into the water cycle of nature. Hydrogen economy is, as already mentioned, a circular economy, and with hydrogen energy consumption can be multiplied without any additional burden to the environment.

The limits lie solely in the energy expenditure required for hydrogen liberation--today in the uranium deposits, but tomorrow in the constantly self-renewing, incredibly large water capital of the oceans with their 1,350 million cubic kilometers of water, because then hydrogen will also be synthesized to helium using nuclear fusion. That will be the time, when man--as Glenn T. Seaborg said in 1970--"has at his disposal as much energy as if the earth contained 500 oceans full of petroleum."

Hydrogen can be stored in gaseous and solid (metal hydrides) form, and presents in its liquid state the most economical of all forms of transportation. It can be transported worldwide by pipelines (already existing as natural gas pipelines) and by tankers. Under ideal conditions, hydrogen and electricity can be transported through the same lines, because the temperature of liquid hydrogen (minus 253 degrees Celsius) is sufficient to make a niobium-tin alloy, suitable as a power cable, superconductive. That means very large amounts of electricity can be shipped long distances, practically without loss.

However, liquefacation of hydrogen requires approximately 28 percent of its energy. Yet not only hydrogen is produced by electrolysis of water, but also oxygen, and oxygen is an excellent energy-saver. Combustion air consists of 78 percent nitrogen, which inhibits combustion and suppresses flames. Pure oxygen, though, reduces the energy demand of ceremic ovens and foundry cupolas up to 40 percent in the treatment of ore and to half in metal melting. The oxygen formed during water electrolysis is "free of charge" and can be used for improvement of the environment, for aeration of lakes, rivers and sewage treatment plants and can accelerate biological decomposition processes.

Hydrogen not only is a fuel and as such can be used to power everything from lawnmower to locomotive, but it is also an essential basic chemical element. Without hydrogen the hardening of oils (and therefore the margarine industry) would be just as impossible as thousands of other industrial processes.

There are, of course, negative factors to be considered. As ideal as a hydrogen economy sounds--there is not enough hydrogen available at this time. The major part of hydrogen now used in technology is obtained with petroleum, natural gas and coal. Only 1 percent, approximately, originates from water electrolysis.

Thermo-chemical water cleavage splitting is still in its experimental stages. Even this can be attributed to bargain-priced oil and gas prices connected with the oil. The profitability calculations today, in ammonia production for instance, are very different. The hydrogen economy helps our industrial society to survive and therefore, certain circles will fight it as much as nuclear energy.

9726
CSO: 3102

SOLAR COLLECTORS EVALUATED FOR DISTRICT HEATING

Frankfurt/Main FERNWAERME INTERNATIONAL in English Aug 80 p 330

[Text] The National Swedish Board for Energy Source Development has granted support to a project concerned with solar heat for district heating. The project is executed by the Swedish Industries' Solar Energy Association (SISOL)--an organisation for companies and consultants engaged in the field of solar energy, in collaboration with the Swedish District Heating Association.

The aim of the project is to test and evaluate solar collectors operating in an existing district heating network. The study, which is carried out at Sodertorns Fjarrvarme AB (a district heating utility), is designed to investigate various systems, overall efficiencies, material problems, reliability, need for maintenance, etc. at a given site and over a long period of time. Solar collectors from different manufacturers and several product generations are being tested in this study.

The background to the project is that, since about 25% of all heating in Sweden is by district heating, good opportunities should be available for finding satisfactory solutions to the utilisation of known techniques and known components in existing systems. The fact that district heating is expected to expand significantly during the next 20 years renders it particularly interesting to study the matter. Even today, district heating systems have the potential to absorb 3 TWh of solar energy--a figure (fig. 1) [not reproduced] which a State investigation has assumed to be attainable in 1990. Preliminary estimates also indicate that the specific cost of solar energy per kWh in district heating systems will be at about the same level as the Swedish cost of electrical energy.

The solar district heating systems selected for evaluation are considered to be preferable, since they enable solar heat to be utilised immediately on a large scale and using known techniques and since opportunities are thus provided for industrial mass production. In addition, the costs of distribution, accumulation and of adapting the buildings will be eliminated. It is expected that the system will provide an appreciably higher energy yield for a given capital expenditure than the solar heat alternatives known today.

A high efficiency can be attained, since most of the distribution losses are already present in the conventional system and since an unavoidable heat loss from the accumulator is eliminated in this system. Other advantages of including the system in an existing district heating system are obviously that an operation and maintenance organisation is already established and that stand-by capacity for reliable supply is available.

CSO: 3102

ENERGY

SMALL WIND GENERATOR LAUNCHED ON COMMERCIAL MARKET

Oslo NORGES HANDELS OG SJFARTSTIDENDE in English 31 Oct 80 p 35

[Text]

A wind generator which can supply a small house with enough energy to power lights, refrigerator, radio and TV, kitchen fan, water pump, etc., has been launched on the market under the name of Fourwind by the Nordkalotten Trading Company, Luleå, north Sweden.

Power supply is not interrupted by any sudden drop in wind force as four 12 V, 60 ampere-hour storage batteries guarantee a reserve of more than 2 000 watt-hours, it is stated.

Two versions of the generator — which is of a new, patented construction, without brushes — are available, one for winds averaging 9-11 mph (4-5m/sec) and one for 11-13 mph (5-6m/sec) winds. The latter has a charging capacity of roughly 300 W at a wind speed of 20 mph. There are two charging intervals — for high and low winds — and charging starts at a wind speed of 7-9 mph.

The Fourwind unit has a 2-metre-long propeller made of wood or aluminium. The asynchronous generator incorporates a dynamically-balanced rotor with high-quality bearings that give high operating reliability and low noise levels. The generator is mounted on a wind vane and at high winds the propeller angles upwards to reduce generator speed and overall stress.

An electronic unit is connected to the generator, batteries, and accessories. It automatically switches over to a higher charging rate when wind speed exceeds 13 mph. The unit houses the voltage regulator, ammeter, safety fuse, and magnetising components.

CSO: 3102

ENERGY

HEAT FROM POWER STEEL, CHEMICAL PLANTS FOR DISTRICT HEATING

Frankfurt/Main FERNWAERME INTERNATIONAL in English Aug 80 p 305

[Summary of report by Werner Wein, Kurt Konge and Hans Hoffman: "District Heat Supply in Duisburg From Heat and Power Plants With Circulating Atmospheric Fluidized Bed Combustion, From Steel Works and From the Chemical Industry"]

[Text] 1. Introduction

In the city of Duisburg the total space heating requirement is ca. 4,815 GWh.. 60% of this requirement is supplied by electricity, gas and district heat. The remainder by coal or oil. The Municipal works Duisburg supplies the major part of the energies electricity, gas and district heat. Currently district heat covers approximately 25% of the domestic heating requirement. The majority of the heat is generated by heat and power plants of the Municipal Works. These plants are operated by hard coal and natural gas.

2. Heat and power plants with "circulating atmospheric fluidized bed combustion"

A rational supply of electricity and district heat to conurbations while simultaneously fulfilling conditions for environmental protection is becoming increasingly important. Here, heat and power plants located close to consumers can make a substantial contribution. Because conventional generating plants use almost exclusively hard coal as primary energy source, special measures to comply with more sophisticated environmental demands need to be determined. The operation of a novel burner technology "circulating atmospheric fluidized bed combustion" is regarded by the city of Duisburg as a pace-setting solution.

In this type of combustion a specially ground mixture of coal and limestone is burned in the fluidized bed combustion chamber at a temperature not exceeding 900°C. The combustion chamber is filled with gas fumes having a high stable matter content which, according to load, stream upwards at 3-6 m/s. A significant portion of this stable matter is separated from the gas fumes in centrifuges and fed into flow coolers or returned to the combustion chamber. The gas fumes flow over a supplementary heating surface and are then cleansed at 320°C by a hot gas electric filter. The gases leave the system via convection preheaters with a discharge temperature of 130°C. [as published]

The connection of water/steam circulation is possible in natural and compulsive flow circulation principles. According to present-day knowledge, an output of 150 MW electrical can be constructed in a module. In a series of experiments hard coal with varying calorific values and sulphur contents was burned under different conditions of combustion air quantity and ca/s molecular ratio. The positive results obtained in relation to the desulphurisation of the gases released and the low formation of NO_x prompted the Municipal Works Duisburg to plan steam generation with circulating atmospheric fluidized bed combustion for an existing heat and power plant with 70 MW electrical and 50/65 MW thermic output. This is a joint project between the concerns Lurgi Chemie and Huttentechnik GmbH, Frankfurt (Main), and Deutsche Babcock AG, Oberhausen. Currently engineering work is being carried out at the Municipal Works for erection of the fluidized bed combustion plant. The project is being subsidised by the Ministry of Research and Technology under Code No ET 1162.

3. Industrial waste heat for district heat supply

Alongside the decoupling of district heat from heat and power plants the Municipal Works Duisburg, in conjunction with various steel and chemical concerns, have created methods of utilising industrial waste heat for space heating purposes. At the Friedrich Krupp Huttenwerke AG the tangible and chemically latent heat from convertor waste gas is used. An excess heat boiler with supplementary wet filter produces steam or high temperature water using the CO-rich waste gases at 1700°C. The waste gases are also used in underburners for steam boilers. Heat won in this manner can be used both in industrial processes and in district heating systems. The district heat is conducted by a heat pipeline to the supply regions in the suburb of Duisburg-Rheinhausen where it relieves existing heat plants. In addition, the availability of the industrial waste heat, ultimately 85 MW will be available, facilitates a broad extension of the supply within Duisburg-Rheinhausen.

In Duisburg North at the Thyssen concern heat is decoupled from steel production and processing. One System uses waste gases at 200-370°C from a Cowper plant of a blast furnace to heat the district heat circulation water. With another method district heating water is used to cool hot gases at 400-650°C in waste gas heat exchangers. In this way a heat amount of up to 465 GWh/a can be fed into the district heat system from waste heat generation.

In the northwest of the city the chemical firm Sachtleben is constructing a plant to make use of waste heat from sulphuric acid production. Heat generated by the cooling sulphuric acid heats up the district heat circulation water. A heat output of up to 37 MW is thereby released for the district heat supply.

To transport waste heat to the existing supply regions in the north and northwest of the city and to the neighbouring towns Moers and Dinslaken, a district heat pipeline with a length of 28 km was built. To carry out and to later operate this project the municipal works of Duisburg and Dinslaken founded the District Heat Combine Lower Rhine Duisburg/Dinslaken.

Industrial waste heat is usually production dependent and is produced in unspecified quantities. For these reasons the existing heat plants in the supply areas remain fully operable to supply peak loads or as contingency reserve.

Due to the national significance of the projects described here the Federal Government and the State of North Rhine Westphalia are providing full support.

Goals of these programmes are the establishment of methods for more economical and rational use of energy with simultaneous improvement in environmental conditions.

CSO: 3102

PATENT SOUGHT FOR ARCTIC OIL DRILLING PLATFORMS MADE OF ICE

Oslo AFTENPOSTEN in Norwegian 4 Nov 80 p 23

[Article by Rolf L. Larsen: "Oil Drilling Platforms Made of Ice for Use in Arctic Areas?"]

[Text] Stavanger, 3 November. Oil installations made of ice can become a reality already at the end of the 1980's. Already next year a Norwegian-developed oil drilling model built out of ice will be displayed at the petroleum exposition in Houston. It is the world patent applicant for this idea, Oslo attorney Eystein Husebye, who has told this to AFTENPOSTEN. On Monday he and glaciologist Olav Orheim from the Norwegian Polar Institute presented the research data they have now obtained in this area, during a lecture about the petrochemical course of study at the district technical school in Rogaland.

Glaciologist Olav Orheim, who is an international expert as far as glaciology is concerned, both in Arctic and Antarctic areas, was contacted by Eystein Husebye a half year ago. Husebye then asked Orheim to study more closely the feasibility of building oil installations made of ice.

Orheim was able to relate that the English already during the Second World War in great secrecy experimented with building airfields made of ice in the Atlantic Ocean. Model experiments were performed on this in North Canada. Here a model measuring 20 X 10 meters was constructed and it was built of ice and sawdust. Besides the fact that the model demonstrated that after a year it was very solid and withstood stresses well, it was also learned that the energy requirement for keeping the ice firm is very low.

Now Orheim will, during an expedition to the Antarctic which he is to accompany, study the stresses of ice with a view toward the construction of oil installations made of ice. Here he will see, for one thing, how waves affect ice.

Husebye has also recently completed a preliminary research project for Det Norske Veritas. And these results also show that ice mixed with other insulation materials has very good properties. The Oslo lawyer has also had conversations with Aker Engineering, which has also shown interest in the project.

"I have made a number of investigations of the Arctic regions and have collected information and have had conversations with the Canadians regarding how they drill

for oil in the north. The idea I want to launch is a large platform made of ice. It will be about 200 meters long and about 60 meters high. By building a steel platform or a concrete wall as a shell around the ice mass itself, and with a special means of insulation on the inside, it will be possible in Arctic areas to be able to keep the temperature down with very low consumption of energy all year long," says Husebye.

He believes that if one gambles on building installations of this kind it will be possible to build them for about one fifth of the price it costs today to build a similar installation made of steel.

Safetywise such a structure will also be totally competitive with today's. The installation is intended to be placed on the floor of the ocean areas in which they will operate. Thereby they freeze solid to the rock below and this will prevent the installation from capsizing. The oil drilling installations will also be so large in dimensions that it is possible to separate the drilling and production sections from the living area on board, and thereby establish a safety zone in the middle which can be separated immediately if a fire should break out on board. Husebye points out that the mixture of ice and other material will be able to withstand just as great stresses as steel and concrete, even if a fire should break out on board.

8985
CSO: 3102

POSSIBLE USE OF FLUIDIZED BED COMBUSTION

Amstelveen ENERGIESPECTRUM in Dutch Jun 80 pp 142-149

[Article by J. B. Fortuin: "Application Possibilities of Fluidized Bed Combustion of Coal in the Netherlands. Part I: Atmospheric Fluidized Bed Combustion (AFBC)"]

[Excerpts] In this article, an impression is given of the recent international developments in the area of atmospheric fluidized bed combustion. The Dutch energy situation is also elucidated briefly, as well as the role which fluidized bed combustion of coal at atmospheric pressure might play in this context.

A subsequent article will deal with the subject of the PFBC technique (fluidized bed combustion under pressure).

The technology regarding the combustion of coal and other fuels according to the fluidized bed principle is, at present, at a rather advanced stage, in which connection particularly the large number of research, development and demonstration projects in operation or in preparation is very striking. These projects are primarily in the United States, the German Federal Republic and Great Britain.

Up till now, most of the techniques used for producing hot flue gases by means of coal have been based on combustion either in a fixed bed above a grate, possibly a moving grate or chain grate, or in a pulverized coal burner, whereby the very finely ground coal or lignite particles burn in a strong air current at a high temperature.

An alternative method is now the burning of coal particles in a fluidized bed. The 'fluidized bed' technique is already old (from long before World War II) and is based on the principle that a layer of granular material through which a gas flows will act as a fluidized bed, acting somewhat like a fluid (see figure 1). The rate of speed of the gas must then exceed a minimum value, the minimum fluidization speed. The

particles will hereby be brought to a condition of apparent weightlessness and will move through the entire bed; the main pattern of the current consists of a central upward movement and a downward movement along the walls. One can keep increasing the rate of speed of the gas, whereby, however, first the lighter and subsequently also the heavier particles will be carried along with the gas current. The substance then disappears from the bed, and pneumatic transport sets in.

This technique, which has been used already for a long time in chemical technology, in connection with the excellent contact between gas and solid substance, has, since the early sixties, also been proposed for the burning of granular substances or heavy fuel oil in a fluidized bed otherwise consisting of inert particles. The coal content in the bed amounts to from 1 to 3 percent.

The potential advantages of such an application are primarily:

The specific heat development (per volume unit) is very great, which results in small boiler installation measurements.

Only a small heat exchanging surface is necessary to convey the produced heat from the bed as a result of the relatively high heat transmission coefficient between bed and the pipes mounted in that bed.

The sulphur present in the fuel can in the bed be absorbed by a carbonate, mostly limestone (calcium carbonate), sometimes dolomite, which binds the sulphur dioxide formed after calcination to sulphite and, subsequently (in the presence of oxygen) to sulphate. In this way, the sulphur can, in its trapped state, be removed from the bed simultaneously with the remaining ash, whereby air pollution through SO_2/SO_3 emission, to a large extent, can be prevented.

Also the production of the air polluting NO_x ($= NO + NO_2$) is reduced to a significant degree, as a result of the relatively low combustion temperature, which ranges between 750 and 925°C.

Practically all kinds of coal, also inferior kinds with a very high ash content and lignite, can be burnt without problems.

As disadvantages can, however, be mentioned:

If sulphur absorption is used, a larger quantity of ash will have to be removed than in the case of conventional combustion techniques.

The system is more difficult to regulate than other systems, but after more development work this can probably be improved.

The installations are still very expensive. However, when produced in larger numbers, their costs will, no doubt, decline.

Present Stage of Technique

The development of hot water and steam boilers according to the fluidized bed combustion principle has been continued for the last few years with increasing success. It can be said that there will be no further big problems to solve, as far as boilers with a capacity of up to 100 to 150 tons/h steam production (80 to 120 MW_{th}) are concerned.

It is not possible in this article to describe all the projects abroad that are in the process of construction and in operation. However, a few representative and important demonstration projects in West Germany should be mentioned here.

In that country, different AFBC projects are now in preparation and in operation, the most important industrial enterprises involved being: VKW (Vereinigte Kessel-Werke, a subsidiary company of Deutsche Babcock, Oberhausen) and Thyssen Engineering Inc. The former industrial enterprise has supplied the "Flingern" installation, a boiler rebuilt into an AFBC boiler with a capacity of approximately 40 MW_{th}, which provides hot water for town heating.

Another installation supplying heat for town heating is the installation at the "Koenig Ludwig" mine near Bochum in the Ruhr district (figure 2). This is a boiler installation designed by Thyssen Engineering and built by Standardkessel Duisburg, which has a capacity of approximately 9 tons/h steam of 18 bar, i.e. approximately 7.5 MW_{th}. Table III gives further details on this installation, which the Ministry of Research and Technology of the Federal Republic has helped finance.

The installation went into operation in October of 1979 and functions completely as desired. The starting is, by means of oil burners located above the bed, very fast (approximately 1 1/2 hours). Both installations, the "Flingern" and the "Koenig Ludwig" installations, will be tested extensively by order of the West German Ministry of Research and Technology, whereupon further spreading of the use of this technique in West Germany is expected.

Among the other demonstration projects in Europe, a 25 MW_{th} AFBC installation in the Swedish town of Enkoping, finally, deserves to be mentioned. The installation consists of a separate AFBC boiler installation (figure 3), provided with coal pipes located in the bed; this boiler was designed and built by the Norwegian enterprise Mustad, while, behind this boiler installation, a convection boiler has been placed, built by the Finnish enterprise Kymene. Originally designed for burning very heavy, high-sulphur oil, the installation, the purpose of which is to provide heat for town heating, has been adapted to the burning of coal, in which connection, however, a few technical problems still exist.

Situation in the Netherlands

It is today clear that the FBC research and development work will also get started in the Netherlands. Dutch industrial-enterprises, TNO, ECN, as well as the Technical Universities of Twente and Delft, have extensive programs in preparation or already in execution. The NEOM (the Dutch Energy Development Company) states that there is today a great need in the Netherlands for AFBC demonstration projects, but these have great difficulties in getting started. This is primarily due to the existing uncertainty concerning the extension of gas supply contracts, the resistance that exists with regard to coal in connection with the inconveniences associated with its use, the absence of any long-term experience with its reliability in operation and the, in many cases, still too small difference in annual fuel costs between burning coal and gas or oil.

Only now, that is to say, after the most recent oil (and thus also gas!) price increases, does coal seem to have become really interesting to industrial enterprises. For, at an oil price of 300 guilder per ton and a coal price of 110 guilder per ton, the price of coal, seen from a calorie point of view, is only 53 percent of that of liquid fuel!

That this leads to clearly lower steam-generating costs will appear from the calculation shown in Table IV of the annual costs when using a 50 tons/h industrial boiler (20 bar) for oil or coal and at an annual operating period of 7,400 hours, calculated on the basis of January of 1980. The possibility of limestone dosing has indeed been taken into account in the investment costs, but not in the exploitation cost calculation. The reason for this is that the operational requirements with regard to air pollution do not yet necessitate that sulphur be trapped when burning coal with a sulphur content of 1 percent or less.

It appears that the more than twice as high investment costs of a coal installation in this case still lead to lower steam production costs, viz. approximately 12 percent lower costs. In the case of a total investment in the coal-fired fluidized bed installation of approximately 17×10^6 guilder, there is an annual saving of well over 1.1×10^6 guilder. The economic prospects are thus definitely favorable. It can be mentioned in this context that Dutch industrial enterprises are prepared, in cooperation with foreign enterprises, to undertake projects for AFBC boilers. The enterprises concerned are the following:

Stork K.A.B. in cooperation with Babcock & Wilson, Great Britain

Bronswerk K.A.B. in cooperation with Mustad, Norway

Royal Mines De Schelde in cooperation with Combustion Engineering, United States

H.C.G. (Leiden) in cooperation with Deutsche Babcock Gesellschaft, West Germany

Engineering Works Breda, formerly Backer and Rueb, in cooperation with Thyssen Inc., West Germany

Vervolme Engineering Works, IJsselmonde, in cooperation with Foster Wheeler, United States.

By way of illustration, an example is given in Figure 4 of the AFBC boiler designed by Bronswerk K.A.D. in cooperation with O. Mustad & Son Inc., Oslo, for industrial use.

Further developments on the part of Dutch industry and a meaningful supporting research and development program, however, can only be based on the rapid execution of demonstration projects. It is then also to be hoped that there will shortly be a demand for AFBC boilers from the above enterprises, so that Dutch industry can build up its experience, and the research and development work in industrial developments will bear fruit. It is, in this context, of great importance that a demonstration boiler, although a modest 2 MW boiler, for central heating purposes, be installed at ECN at Petten.

Possibilities of Using Atmospheric Fluidized Bed Combustion in the Netherlands

With regard to the use of AFBC systems, it is pointed out that three arguments today play a role in the Netherlands:

A reduced supply of gas and oil, coupled with price increases.

Increasingly stricter environmental legislation, making measures to limit SO_2 emissions increasingly necessary.

The expectation that AFBC boilers can be built more compact than other types of coal-fired boilers.

To arrive at a prognosis for the future use of this new technology in the Netherlands, quantitative forecasts should be made regarding the abovementioned effects, as well as regarding the increase in energy consumption in general. Below follow a few forecasts, as far as possible linked to prognoses already made by others, for example the study entitled 'Gas and Electricity in the Netherlands' which appeared in 1978 and was prepared by a working group organized by ECN and TNO.

Public Electricity Production

For the year 2000, it is assumed that the ratio between the consumed fuels coal/fissionable material/oil + gas for public electricity production will be approximately 1:1:1. This implies, at a moderate economic growth rate, an installed capacity on the basis of coal of 6,000 MW_e. For this, a quantity of coal of 13×10^6 tons a year is necessary. Even if rather low-sulphur coal of a sulphur content of 1 percent would be used, it would still mean an SO_2 emission of 250,000 tons a year.

This would then be considerably more than the present SO_2 emission from all plants, which amounts to approximately 150,000 tons a year. It is also to be expected that, toward the end of the century, a number of plants will have to use waste gas desulphurization, while through a successful further development of the AFBC technique a few units based on fluidized bed combustion of coal can be in operation. As the FBC technique, for the time being, does not lend itself to large basic units of 400 and 800 MW, it can be assumed that there will be a modest penetration of a few units of 200 MW_e. In this connection, four favorable locations (Gertruidenberg, Dordrecht, Eemshaven, Maasvlakte) could, for example, be mentioned for placing units with a total capacity of 800 MW_e. This corresponds to a degree of penetration of 15 percent and an annual coal consumption of 2×10^6 tons.

It should be noted that within the FBC market two submarkets can be distinguished, the AFBC and the PFBC markets, which influence each other mutually. A successful development of the PFBC installation will thus, no doubt, cause a reduction in the AFBC market.

In addition to the improved waste gas desulphurization systems, coal gasification, whether or not directly integrated with electricity production, will probably be used toward the end of the century. The quantity of coal as basic material for coal gasification has been estimated at 8 million tons of coal per year.

Industrial Use

With regard to the industrial use of fluidized bed combustion, the industries are now interested in its use for steam generation, primarily in heat power plants, whereby a significant saving in fuel consumption (on a macroeconomic scale) can be attained. In connection with the relatively favorable cost of the fuel of coal, the industries will have an increasing interest in a technique based on coal when the attractive natural gas is lacking.

The natural gas policy is in the Netherlands aimed at replacing natural gas as fuel in larger steam generators by oil and coal. For that reason, a number of current contracts for delivery of natural gas as energy source to industrial customers cannot be extended after the expiration date. In such cases, the use of AFBC boilers can become attractive. The penetration of these installations will, moreover, naturally be dependent on the need for desulphurization, the availability of oil as an alternative fuel, a proven dependability in operation, and the cost price of the complete installations. For the year 2000, an industrial coal consumption of 8.5×10^6 tons per year is expected. This would primarily be burnt in heat power plants where the emphasis will be on conventional pulverized coal burning in larger boilers, whether or not in combination with waste gas desulphurization installations. As the FBC technique can become of great significance for the extensive market of smaller industrial boilers, the following breakdown can, for example, be imagined for the end of the century:

AFBC installations	35 percent
PFBC installations	25 percent
Pulverized coal installations	40 percent
Total	100 percent.

This will, for AFBC, imply a coal consumption of 3×10^6 tons a year, which, for example, corresponds to 100 boilers, each of 40 tons/h steam production, at an annual period of operation of 7,000 hours.

District Heating

Coal will also be used for the production of heat for district heating projects, to a large extent coupled with the supply of electricity.

As is well-known, the aim is that toward the year 2000, 350,000 Dutch homes will be connected to district heating systems. This implies a thermic capacity of approximately 4,500 MW_{th}. Of this, approximately 40 percent, that is to say 1,800 MW_{th}, will have to be supplied by so-called auxiliary heat boilers. Some of them can be made as AFBC boilers. If it is assumed that this number will amount to half the total number, this will correspond to 900 MW_{th} installed capacity and an annual coal consumption of 0.3×10^6 tons.

The advantage of using AFBC boilers for district heating purposes is that this gives a direct replacement of the costly natural gas, and that the coal burning, in connection with the favorable environmental aspects of the fluidized bed combustion technique, can take place in the close vicinity of, or even in, the areas to be heated. A disadvantage is, however, the relatively low annual operating period of the boilers, while it must be awaited to what extent the adjustment possibilities of the installations will agree with the requirements made for district heating.

Summary Coal Consumption in AFBC Installations

Of the approximately 30 million tons of coal per year which, it is estimated, will be burnt in the Netherlands at the turn of the century, a certain portion will be burnt in AFBC boiler installations. Apart from the use of such installations in seagoing ships, the magnitude of the penetration of these installations can be assumed as indicated in Table V.

Conclusion

On the basis of the present fuel prices, atmospheric fluidized bed boilers with coal as fuel can be attractive, provided the operating period is sufficient, for industrial installations, for example, above 5,000 hours per year.

When the technological maturity of the AFBC installations, with the aid of demonstration projects, is indicated, and the Dutch boiler industry is thereby enabled to acquire the necessary experience in time, it can be expected that the diversification of the fuel consumption desired by the public authorities will also get started outside the electricity production sector in the eighties.

Approximately 2 years ago, at the request of, and in cooperation with, ECN, the Energy Research Center of the Netherlands, a study was carried out by the Engineering Office Comprimo, the purposes of which were to describe the state of the technology in the area of coal burning according to the fluidized bed principle, and to indicate the need for research, development and demonstration projects in the Netherlands.

The results of the study were recorded in a report consisting of two parts:

Part A: "A Worldwide Survey," which gives a summary of the state of the technology and of the scientific research.

Part B: "Use in the Netherlands," which indicates the possibilities of use of this relatively new technique as well as the need for research and development activities and demonstration projects in the Netherlands.

Table III. Data of 'Konig Ludwig' Installation

Steam generation	8,850 kgs./h
Steam condition	18 bar, saturated
Feedwater temperature	102°C
Bottom surface	6 m^2
Number of compartments	3
External boiler measurements	6.5 m (length) x 3 m (width) x 11 m (height)
Type of coal	Aggregate coal, baking coal
Coal transport	3 screw conveyors
Waste gas cleaning	Cloth filters
Air quantity	8,711 nm^3/h
Evaporator at top of bed	7.9 m^2
Bed temperature	760°-850°C.
Rate of speed of gas in bed	1.5 m/sec.
Possibility of return adjustment	60 percent of full load
Coal dimensions	to 30 mm

Table IV. Annual Costs 50 tons/h Boiler

	Unit Price	Annual Costs (10^3 guilder) Oil	Coal (AFBC)
Fuel	Fl.300/ton (oil)M Fl.110/ton (coal)	7,830	4.587
Interest loan premium	8 percent	41	26
Ash removal	Fl.15/ton	-	104
El. energy	11 ct/kWh·	244	596
Maintenance	3-3.5 percent	253	597
Insurance	0.3 percent	25	52
Personnel	Fl.55,000	297	605
Water treatment		10	10
Exploitation costs		8,700	6,577
Interest 10 percent*		421	853
Cash flow		9,121	7,430
Depreciation	15 years	562	1,136
Total costs		9,683	8,566

*Calculated on the basis of average (50 percent) investment costs, i.e. based on a straight-line depreciation

Table V. Coal Consumption of AFBC Installations in Year 2000 in Netherlands

	Capacity	Coal Consumption
Public electricity production	800 MW_e	2 x 10^6 tons/year
Industries	4,000 tons/h steam	3 x 10^6 tons/year
District heating	900 MW_{th}*	0.3 x 10^6 tons/year
Total	5,900 MW_{th}*	5.3 x 10^6 tons/year

*Net heat generated

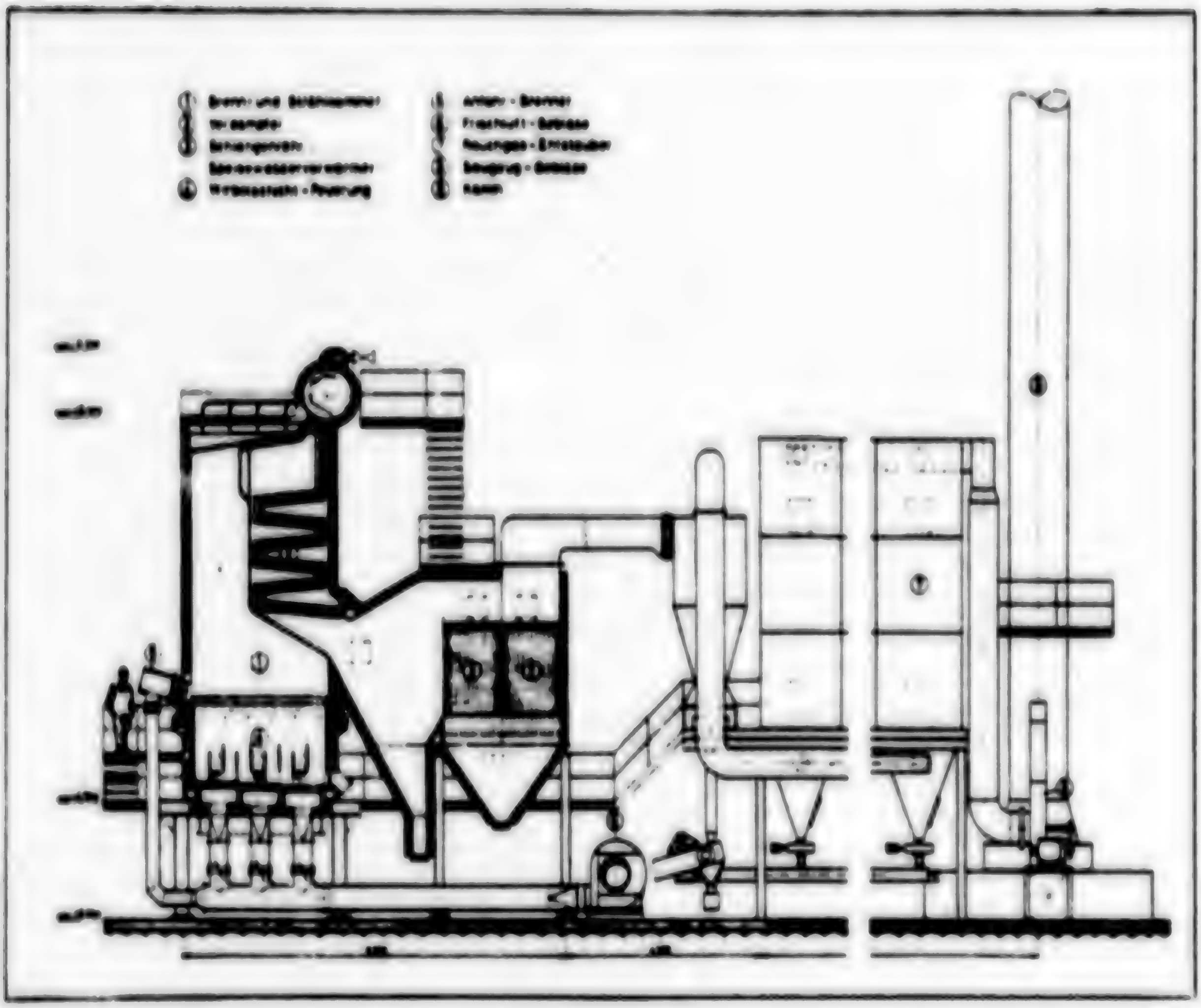

Figure 2. Cross Section of AFBC Installation "Koenig Ludwig"

Key:

1. Combustion chamber
2. Evaporator
3. Spiral tube-feed water preheater
4. Fluidized-bed combustion
5. Starting burner
6. Fresh-air ventilator
7. Flue gas dust box
8. Upward draft ventilator
9. Chimney

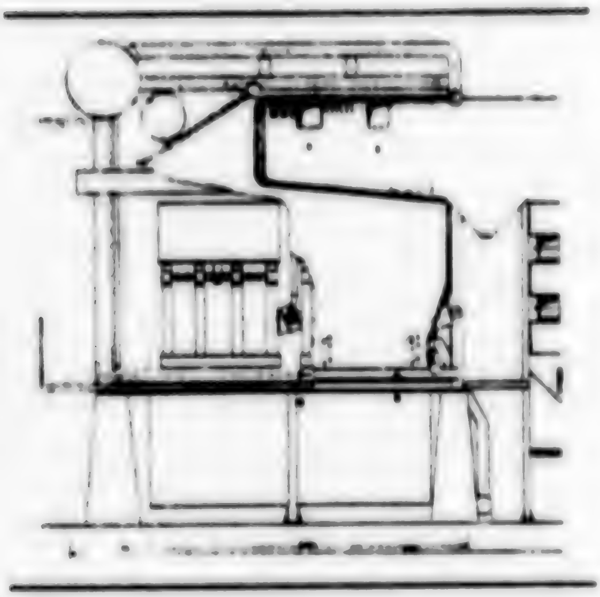

Figure 4. Cross Section of Industrial Fluid Bed Boiler for 50 tons/h Steam Production, Designed by Bronswerk-Mustad

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7262
CSO: 3102

BRIEFS

DISTRICT HEATING FUEL POLICY--Six new district heating power stations (stations designed for combined generation of electric power and heat for district heating) are being planned in Sweden today and three are now in the course of construction. Out of the stations being built and to be taken into operation in 1981, two will be oil-fired, whereas adjustments will be made on the third to enable it to be fired with coal instead of oil. Out of the six stations planned, two include plans which comprise oil and coal alternatives, whereas three intend to use coal, in one case with peat and wood chips as a supplement alternative. The sixth station will use blast furnace gas in collaboration with a Swedish iron and steel mill. The development towards new fuels is illustrated even more clearly by considering the fact that only two of all existing district heating power stations employ, to some extent, fuels other than oil. Pure district heating stations are also focusing increasing interest on alternative fuels. The alternatives primarily considered are coal, wood chips from forestry waste and smallwood, and peat. [Excerpt] [Frankfurt/Main FERNWAERME INTERNATIONAL in English Aug 80 p 330]

CSO: 3120

INDUSTRIAL TECHNOLOGY

TRENDS IN INDUSTRIAL AUTOMATION DISCUSSED

Hamburg DIE ZEIT in German 26 Sep 80 pp 25, 26

[Article by Richard Gaul: "Hugo Is Not a Robot. Factories Without People Are Still Utopia. German Automobile Industry Wants Greater Rationalization. Will Automation Cost Jobs?"]

[Text] Nothing is moving. Two finger-thick copper teeth seem to be lying in wait for something--they remain at eye level of the observer, ready for the "bite." With a jerk they turn toward silvery sparkling sheet metal, the side panel of a Mercedes body. The metal arm which holds the copper tongs lurches forward, the teeth bite into the metal, sparks fly, the teeth open up--a welding point has been made.

The teeth systematically "eat" their way along, welding point after welding point is burned into the sheet metal. Then the arm springs back, the tongs once again turn toward the observer, the work is done--until the next automobile side panel comes along.

"That is how we will beat the Japanese," says Werner Niefer, head of production at Daimler-Benz. "That" means the robots which are welding together the car bodies of the new S-class in Sindelfingen. It also means all the other machines which the company uses to build its automobiles; it means the level of automation which has been reached in Stuttgart.

Industrial robots, machines which can be freely programed and can move in various axes with their claws, have since come to be a symbol of modern technology--chiefly in the automobile industry. The cliche of the "Japanese robot factories" is making the rounds--and it describes reality just as spectacularly as it does falsely.

What is meant are almost peopleless production shops in which machines apparently work by themselves. But that does not apply just to Japan. Anyone building a new plant today uses methods like these anywhere in the world. Any "robots," whether in Japan, the United States or the FRG, do, of course, play an increasingly larger role, but by no means the decisive one.

Hans-Juergen Warnecke, head of the Institute for Production Technology and Automation of the Fraunhofer Company in Stuttgart and FRG robot specialist, has registered approximately 10,000 of these industrial robots, or "automatic handling machines" as the technicians call them, throughout the world; between 3,000 and 4,000 are in operation in both the United States and Japan, more than 2,000 in Europe and approximately 1,000 in the FRG. Almost every second robot in the FRG is in an automobile factory. Another large use is the electrical industry.

Of course, these machines have little in common with the robots in science fiction films and novels. They are not the artificial people of Czech author Karel Capek, who invented their name in the 1920's, deriving it from the word "robota" (slave labor). Today's industrial robots are firmly bolted to the floor of the production shop. A long metal arm with a claw, an electrode holder or a varnish spray gun mounted at the end. The "foot," a pivot mounting, is similar to the carriage of a light cannon. The "brain," the computer which controls the machine, is concealed in an inconspicuous sheet-metal box next to the robot. Almost identical machines can, depending on the program, weld, varnish, apply protective undercoating or place parts in large presses.

Experts Not Agreed

The experts still disagree as to which automatic machines are actually robots. Thus, Mackintosh Consultants, in a study for the Ministry for Research and the Ministry for Labor, considers machines for simple acts of assistance to be robots--and thus arrives at a worldwide inventory of over 100,000 devices. For Stuttgart robot professor Warnecke, however, those are only automatic machines. The concept of robot, in his opinion, presupposes that the machine can be freely programmed, thus that it can be used in various sectors.

The industry shares the professor's nomenclature--of course, the word has not yet gotten around in the production shops: while the very modern welding robots at Daimler-Benz keep on working without any name, a simple "automat," which places the spare tire in the luggage compartment, has a name--the workers have pasted on the machine the name "Hugo" in big letters.

Even the "real" robots, which naturally does not include "Hugo," have thus far been used primarily in the automobile industry. There are approximately 300 in the Volkswagen factory; the Wolfsburg conglomerate is not only the largest user of robots in this country, it is also the largest producer of robots. For in 1972 the automobile manufacturer's engineers determined that the equipment suited to their needs was not available on the market--"one-half year later the first prototype of our development was there in Wolfsburg," recalls Gerhard Wolf, director of "Electrical Operations" at Volkswagen. In addition to the Volkswagen robots, which of course have been used thus far principally in their own company, but which are also for sale to other users, Warnecke at present considers only the machines of IWKA subsidary Keller and Knappich, known by the

name "Kuka," to be internationally competitive. To date the company has sold about 170 machines. In the FRG, Fokker United Aeronautical Works and the Friedrichshafen toothed gear factory are also planning to get into robot production.

Daimler-Benz and Volkswagen both say that higher flexibility in production is the chief reason for the use of robots. Daimler's production head Niefer, therefore, always speaks of Bremen as the "second automobile factory" and not as the "factory for the small Mercedes": in a few years the most varied types of a vehicle program are to roll off one production line--at Volkswagen two- and four-door automobiles are already being built on a compound basis.

And even a model change is cheaper when robots are used in production: the company no longer has to purchase a totally new machine, but rather only the so-called "feeds." Wolfgang Jacobi, plant chief at Daimler-Benz in Sindelfingen, figures that in a fully mechanized welding line up to 95 percent of the investment must be written off after a change in type; in production using robots this share is reduced to about 50 percent.

Japan Is Ahead

Therefore, according to Daimler manager Jacobi, the use of robots has no direct effects on the labor market because an industrial robot is installed today in a place where previously there was another machine anyway or where mechanization in another form was under discussion. The old S-class was still being put together by workers using heavy manual electrode holders. Either the installation of a transfer line or even the use of robots was under discussion as a replacement. In view of the smaller quantities of the "big Mercedes" Daimler-Benz decided in favor of the more flexible machine: the robot.

According to Daimler production head Niefer mechanization is indispensable. That is the only way for German industry to maintain international competitiveness, that is the only way to achieve the necessary level of quality.

However, in mechanization and thus in production, the Japanese, as set forth in an internal study at the Volkswagen factory, are still ahead of German automobile manufacturers: "However, in technical know-how the Japanese do not have a lead," in the judgment of robot professor Warnecke. For example, something like the fully automated assembly of rear axles at Daimler-Benz is unique in the world. Of course, Chrysler Corporation in the United States reports that 98 percent of the approximately 3,000 welding points will be made automatically in the new models, the K cars, but for years Daimler-Benz has been automatically welding the entire body in the 200 to 280E series--and in the process makes 6,000 welding points.

The overall increasingly greater automation of factories in the Far East is not so much a result of better techniques, but rather is due to the fact that the Japanese began to build large factories later than their German competitors.

In more recent factories, therefore, more modern production methods were realized. Moreover, the Japanese labor market in the 1970's was swept clean--automation was thus indispensable.

In this respect German automobile makers also began to make early use of robots in production. At the beginning of the 1970's the first machines were operational. In part, however, the factories had bad experiences with them. Klaus Rieger, head of central planning at Opel, says: "In the mid-1970's the robots in Ruesselsheim reacted to radio communication at the nearby Fran urt international airport"; the result was uncontrolled movements. Thus, Opel now wants to make a second start, very cautiously. And Daimler-Benz in Sindelfingen learned the hard way with robots of the first generation which at first were not able to hold the heavy electrode holders. At that time the machines cost up to DM300,000--and for the most part did not provide the expected results.

In hindsight Warnecke says that in the early 1970's expectations in respect to the use of robots were viewed too euphorically. But since then, after "sobering up," people have moved on to a "realistic view."

According to the robot professor, this of course also includes steady growth in the next few years, but no revolution in the use of robots can be expected. Therefore, Warnecke does not see any noticeable effects on the labor market throughout the 1980's. Increasing unemployment, which is to be expected anyway, will not be substantially exacerbated by robots.

Of course, in this respect trade unions are not as optimistic as the professor. Thus, Hans Jaeger of the Metalworkers Union calculates that each robot in two-shift operation replaces approximately 2.4 workers--and by the mid-1980's Jaeger expects approximately 100,000 industrial robots to be in use in the FRG. For the costs speak for themselves: even today one machine is amortized in less than 2 years.

Figures which were somewhat different, but no less alarming, were presented to the Ministry for Research and the Ministry for Labor by Mackintosh Consultants: "According to our estimates the potential loss jobs in the FRG will be on the order of 10,000 to 30,000 by 1985-1986 and by 199u it could be between 200,000 and 500,000."

The consultants go on to say that in the beginning the jobs affected would be primarily in the automobile and accessories industries, then from 1985 on also in the assembly of small parts. "Production, delivery and service of robots" would, on the other hand, employ only about 20,000 people; in this respect the study presupposes that the FRG can become "an important supplier in world markets."

And even the much-quoted relief for staff employees by robots is viewed by researchers with skepticism. The Sociological Research Institute in Goettingen discovered in the case of Volkswagen that "in spite of the in-part clear decrease in physically hard work and negative environmental influences, things have gotten

worse in the work situation in individual cases." Psychic strain, being tied to rhythm and monotony have increased. The sociologists find fault with the fact that "the conversion (to robots) was implemented exclusively on the basis of technical considerations."

Americans also anticipate greater effects on the labor market from the use of robots: General Electric manager Harry Geller explained in the business magazine BUSINESS WEEK: "We have gained experience with jobs which people perform only reluctantly; now we are beginning to use robots where we have the most employees."

On-going reduction in costs of electronics will, in the opinion of the experts, also make robots increasingly more cost-favorable. Machines which today still cost several thousand marks will be definitely cheaper--or else more efficient industrial robots will be available at the same price. Machines that can "see" or "feel" are already being tested in the laboratories: computers analyze a picture transmitted by a video camera, electronic computers register, by means of sensitive detectors, the pressure exerted by the grippers on a work piece, such as the bulb of a television tube. It is, however, not very likely for devices of this kind to be adopted very soon in everyday production--optimists thought 10 years ago that the seeing robot was just around the corner.

With respect to the revolutionary changes in labor predicted by BUSINESS WEEK, Warnecke cites experiences with the use of numerically controlled machine tools. Machines of this kind have been on the market for 25 years -- and it is only now that they are being purchased by small and medium-sized firms. Should industrial robots follow this pattern, then the bulk of jobs in the FRG would not be affected until the mid-nineties -- and then there will be a lack of manpower again here.

12124
CSO: 3102

USE, IMPACT OF INDUSTRIAL ROBOTS SURVEYED

Duesseldorf WIRTSCHAFTSWOCHE in German 29 Aug 80 pp 30-32, 35

[Text] German industry must modernize if it intends to keep pace in international competition. The use of industrial robots will increase and the next generation of robots will even be able to see and feel.

In August 1977 two movie stars immortalized their footprints in wet cement in front of Hollywood's "Mann's Chinese Theatre," right beside those of Clark Gable, Ava Gardner and Judy Garland. But the film greats could not notice the applause of the crowd and the flashing lights of photographers. The stars of the successful film spectacular "Star Wars"--Part II has already been released--are robots. As R2-D2 and C3-PO they amused the onlookers of this future spectacle with droll behavior and frivolous speeches.

The pair belongs among those few robot products of the human imagination which do not send cold shivers down the backs of readers or viewers. The artificial man, Golem, from Jewish mysticism and the robot of the Czech writer Karel Capek desire to dominate and remove their creators. It was Capek who, in 1921, coined the name for the technical monsters in his science fiction novel. He took the concept from the Czeck word "robota," which means something like drudgery.

Half a century later, robots have long been more than just a product of the imagination. Their brothers in reality in no way make attempt on human life, rather they have replaced them at their jobs.

Worldwide there are presently about 15,000 industrial robots or--as technologists call them--automatic handling machines, in use. Prof Hans Juergen Warnecke, director of the Fraunhofer Institute for Production Technology and Automation (IPA) in Stuttgart, defines them as "multiaxial, freely programmable automatic handing devices equipped with gripping devices or tools designed for industrial use." The iron and fine steel structures with electronic brains, usually controlled by microprocessors, work hard. Their abilities extend from spot welding, grinding, polishing and coating to handling compression or injection molding machines and presses.

Industrial robots are actually not a modern invention. One of the oldest examples comes from 1934 and is in the plant museum of Ford Motor Co in Dearborn. Even a quarter century later, the automobile industry is still one domain for the use of mechanical helpers. The increasing competition in all markets is forcing more and more manufacturers worldwide to use flexible and freely programmable robots.

While the American Ford Company is one of the first users, the German subsidiary has retooled to robot technology with the production of the new "Escort" model. In the Saarlouis plant, the workers from Cologne installed 40 welding robots just a few days ago. In coming years, Ford will employ between 350 and 500 robots in all European plants. The decision was made after a European Ford delegation visited automated Japanese auto builders.

The reason for the advance of the Japanese does not lie in a more highly developed sense for the future. When the German producers in the 1960s wanted to expand and encountered a tight labor market, they were able to import foreign guest workers. The Japanese could not follow suit, so with massive state support, they moved toward automation and robot technology. Today there are at least 7,500 industrial robots working in Japan, more than in any other country in the world. Ulrich Eckstein, director of manufacturing and plant technology at Ford-Werke in Cologne, recalls his own visit to the Far East: "The Japanese were using more robots than we--but from the viewpoint of production and technology, they have nothing not also found here."

A pioneer among the German robot users is the prestigious Daimler Benz AG. As early as 1971 the Stuttgart plant installed a spot welding line--and had poor results. The robots produced by Unimation Inc. in America and delivered by the subsidiary Keller & Knappich--called simply "Kuka" by technologists--to Industriewerke Karlsruhe Augsburg (IWKA) AG, were not able to bear the heavy welding tongs. With much effort, Daimler and Kuka engineers succeeded in rebuilding the "Unimat." "Because the automatic handling machines could not meet the demands of our customers, we began in that same year to develop our own robots" explained Burkhard Wollschlaeger, IWKA board member. Today, Kuka robots are welding the new S-class at Daimler Benz. Even Ford ordered Kuka robots and Kuka's newest robot, a portal model that can weld whole assemblies together, is being used by BMW.

The company made DM 10 million sales of robots in the preceding year and intends to boost this figure to DM 13 million this year and projects DM20 million in sales in 1981. "In our medium-term planning, the talk is of DM 50 million" explained Wollschlaeger optimistically.

Kuka is not however the largest German robot producer. That is Volkswagenwerk AG. The auto builders produce the robots for their own use. Today, in domestic VW plants, 297 robots are at work. When VW completely restructured its line of models at the beginning of the 1970s and had to switch from the single beetle model to a number of models, the company directors immediately decided to use robot technology. Because the models of robot available at that time did not meet the needs of auto builders, the Wolfsburg plant developed its own.

But attempts to place the four VW robot models on the market at quite reasonable prices of DM 120,000 to 280,000 through distributors failed because of Wolfsburg's half-hearted efforts and because the competition among automobile manufacturers recoiled for image reasons from using VW robots in the production of their own autos. The five robots produced weekly at VW are "for our own use," as Gerhard Wolf, chief department director of electronic operations in Wolfsburg explained. During model changes, they are gradually coming into use. Wolf estimates that Volkswagen will have about 600 to 650 industrial robots in use by 1983.

Although the independent robot manufacturers were not able to do business with Germany's largest automobile company, they are counting on a tremendous increase in

demand. Not only German suppliers hope for a thick slice of the German robot pie: The American Unimation Inc is firmly established in the market, in spite of the failure at Daimler Benz of 181 robots. Another recognized supplier is the Swedish electronics company, Asea AB. It moved to the forefront with 24 machines, among others, sold to the Osnabruerck chassis builder Karmann GmbH. New on the German market is the second largest American Industrial Robot Company, Cincinnati Milacron Inc, and just last July, American Prab Conveyors Inc founded a subsidiary in the Hessian Urberach in order to conquer the European market.

The American market research institute Frost & Sullivan Ltd gives them all reason to hope for good business. According to a market study, the number of automatic handling machines in Europe will grow from about 2,400 today to more than 20,000 by 1990. The market researchers assume that more and more users outside the automobile industry will recognize the advantages of robots. Although the purchase price is only half the total cost of fitting the robot for production in its particular environ, according to Frost & Sullivan, a robot pays for itself after only 3 years. The Frost paper is based on the prognosis that soon a new, more intelligent generation of robots will appear on the market.

"Today a robot can do tasks which could be performed only by a blind, deaf and dumb human wearing thick gloves" explained Dr Rolf Dieter Schraft, deputy director of the IPA Institute in Stuttgart. A large number of industrial jobs requires not merely mindless handling functions, but include complex assembly, test and monitoring tasks.

So today there are no difficult problems in the use of robots for spot welding or coating tasks. But deburring is more difficult: Today, a robot is able only in individual cases to force a flesh and blood worker out of a job. The problem: cast parts for deburring are relatively inaccurate and have large tolerances. "Then it may happen that the robot will grind into the work piece at one point, and on another work piece the grinding may be in the air," explained Schraft.

Throughout the world, scientists are working to give robots "human capabilities" by using sensors. These sensors can be visual, tactile or even auditory: They should enable the sightless work machines to feel, touch or react to optic and acoustic signals. In many laboratories such events are already possible.

ONe of the world's leading robot research institutes is SRJ International, previously the Stanford Research Institute in Calfiornia. The Americans are working on sensors which will enable a robot to "feel" and "see" and certain mechanisms will be combined with speech input.

The IPA Institute in Stuttgart has developed a robot which can discriminate with the aid of a TV camera whether its gripper has grasped a programed work piece. Otherwise the gripper moves back to the start position and tries again. At the same time, the robot optically scans the part and separates out improper or defective pieces.

In technical and user circles, the optic sensor system of the Swiss Electronic company Brown, Boveri & Cie is given a good chance to get beyond the testing stage and some day go into mass production. VW is working together with BBC.

But other American, Japanese and European researchers are working feverishly on sensor systems. The American journal BUSINESS WEEK reports that the two computer giants IBM and Texas Instruments Inc have already developed assembly robots which can "see" and "feel."

A largely new generation of robots is just around the corner. IPA Director Professor Warnecke considers the 1980s to be especially promising for the use of robots in assembly work. His collegue, Schraft, agrees, but considers overly optimistic visions of the future like the Delphi Forecast of Manufacturing Technology Survey published in 1978 to be "rubbish." In that paper we read that by 1990 robots will be able to perfect assemblies with a human-like capability. Schraft: "Certainly, improvements in control technology by microprocessors and sensor development will bring an increase in potential applications. But I do not see a jump in development."

When asked about the spectrum of future uses, Schraft raves as follows: "This affects all areas where handling processes occur. It extends from assembly work to all corners of the consumer goods industry, like pharmacies where drugs must be sorted and stored, to supermarkets where pears are packed into crates and later removed."

The unions have long been watching technical progress with mistrust. They fear that an uninhibited employment of robots is, in the final analysis, directed against workers who will be driven from their jobs by the "intelligent" automatic machines.

In fact, workers have already had had experiences with the robots. In one study on the social consequences of the use of industrial robots at the Volkswagenwerk, the Sociologic Research Institute in Goettingen (Sofi) e.V., reported that at VW there is a savings per robot of four employees. Compared to this, there is an increased need for 0.3 workers for maintenance and repair.

The Sofi study refutes the argument presented by employers that robots contribute to humanizing jobs because they will only do mindless work and release workers for better types of employment. Only a few of the VW workers questioned by Sofi researchers could report that the use of robots has led to an improvement in their working conditions. For one-third of respondents, there was no change because they were moved vertically to jobs with the same stresses. Another one-third had to accept a deterioration: Through the use of the iron workers, the work tempo or scope increased or the cycle times had deteriorated.

The unions do not intend simply to accept unbridled automation. The outline for the basic program for the special Federal Congress of the German United Unions (DGB) in March of next year specifies that technical inventions and organizational changes can only be implemented "if the interests of workers are considered and unacceptable social consequences are prevented."

At least from robot manufacturers who profit by the massive competition causing increased urgency for robot use, the unions can expect no relief. A deputy of a Japanese company who resides in Germany answered a journalist's question about the sharp competition of Far Eastern producers regarding automation endangering social tranquillity with a statement devoid of understanding: "But that will only affect the Turks."

Spot Welding Robots

Areas of employment of industrial robots in the FRG in 1980.

Employment Area	Number of Industrial Robots	Percent of Total
Coating	155	12.4
Spot welding	339	27.0
Rail welding	138	11.0
Deburring	5	0.4
Assembly	52	4.1
Other	34	2.7
Total I	723	57.6
Work piece Handling		
Pressing	78	6.2
Forging	24	1.9
Compression/injection molding	138	11.0
Machine tools	192	15.3
Other	49	3.9
Total II	481	38.3
Research	17	1.4
Use unknown	34	2.7
Grand Total	1,255	100.0

Source: IPA Stuttgart

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TECHNOLOGY TRANSFERS, RESEARCH-INDUSTRY TIES EXAMINED

Paris L'USINE NOUVELLE in French 25 Sep 80 pp 91-94

[Article by Francois Perrier: "Toulouse: The Science Connection]

[Text] Three hundred laboratories, 5,000 research workers. The scientific potential in Toulouse offers good opportunities to industries with an innovative bent. Yet it is still necessary to knock at the right doors.

Toulouse, September 1979: Upon the request of DATAR [Delegation in Charge of National Development and Regional Action], two unemployed officers leave on a "reconnaissance of technological transfers to PMI [small and medium size industry]. What they discover is a "cushy setup" operated, according to them, by "a few in the know".

The "cushy setup" is Rangeuil, an airspace and scientific complex in Toulouse where there are 300 laboratories and 5,000 research workers. The "ones in the know" are a handful of very innovative PMI who know the right laboratory doors and the route followed by government aid. The story does not say whether the two investigators profited, in their turn, from the lead. But when they handed in their report, they also addressed a message to industrialists, the substance of which was more or less the following: "make a visit to the laboratories, there are things to be had."

It was a diagnosis confirmed by the success of the Regional Innovation Competition organized in late 1979 by ADER-MIP (the Midi-Pyrenees Association for the Development of Training and Research). The association awards three prizes to government researchers so that the latter will make it possible for local industrialists to take advantage of their research.

As soon as the first results of the competition appeared, some 15 researchers proposed a product or a process. The three prize-winning proposals are now being developed: a sound measuring instrument for monitoring people exposed to noise, an apparatus for the treatment of water for medical purposes, and a new irrigation system for which the winner created his own company. The experiment will be conducted again this year. There are indeed opportunities; however, it is still necessary to have access to them.

In this respect, one of the businesses is a good example: SETRIC, a company created in 1972 and now employing 45 people, is mentioned every time a collaboration between industry and research is brought up. Rene Chelle built his company from his contacts with researchers. He was present when the National Center for Space Studies was looking for an associate to develop a technique (e.g., the automation of fermentation agents by miniprocessors); he was available when a laboratory of the Paul Sabatier University perfected an enzyme detector, and he was receptive when a researcher from CNRS [National Center for Scientific Research] decided to spend some time in industry. SETRIC [expansion unknown] has 10 or 12 research contracts in progress at the same time and his partners are no longer exclusively from Toulouse.

"We have the feeling that we have the system going well for us", Rene Chelle admits, which does not seem to overly bother much the researchers: "They are often happy to find a partner, someone to work with. Sometimes, also, it's one of our own ideas that they begin developing." And then, one day, someone said to me: "Mr Chelle, you have the reputation of being a shark who goes to get ideas from the laboratories. But I congratulate you, that's what has to be done!" He was a member of the teaching profession.

Can other SETRIC's exist? "Of course, the scientific fabric of Toulouse is thick enough for new opportunities to appear." The latest one? "Solar energy."

The importance of research in the area is still not well known. Yet there are three universities one of which is a scientific and medical university called the Paul Sabatier University. It has 20,000 students and 10 engineering schools thus making Toulouse the second scientific city of France, after Paris, of course. Research activity in the region is too abstract a matter and too spread out to be made the object of an honors list. The scientific potential in Toulouse, however, is impressive. Elie Bressan can vouch for it; she is in charge of organizing the first International Exhibition for Techniques and Energies of the Future to be held in Toulouse in October 1981.

Conceived as a market for stand-by techniques, this event will be a place for scientists and industrialists to meet. Whether it is solar energy or nutrition, materials or biology, the organizers have had no difficulty in finding competent researchers.

They will have to go farther away to look for companies with similar interests, for, if the grey matter is there, Toulouse lacks a strong industrial fabric. The second university city in France has, for a long time, turned out, for others, engineers and technicians. From 1954 to 1975, the region lost 3.6 percent of its active population while the national average was up to 11 percent. Although the region rates ninth in population, the Midi-Pyrenee region is 17th in the number of salaried personnel in the secondary sector.

No Complex on Either Side

Since the 1960's, DATAR and regional leaders have based a policy of economic development on the importance of research. The tree has grown slowly, but the first fruit has appeared: Rockwell Collins (electronic material) took root in 1978;

LOGABAX [expansion unknown] in 1979, RENIX, a joint subsidiary of Renault and Bendix, for building an electronic automobile, started up in the spring of 1980.

As a direct fallout from space research, the development of the Matra Space installations is underway. The new unit will employ 250 people in 1981; last May the ELF [Aquitaine] group announced the layout of a center for research in biotechnology. It will be operational in 1982 and will employ some 100 researchers. Toulouse's choice is explicit: "We want to take advantage of the scientific and university environment", said Miss Ragaclia, project director.

For large businesses, communication with researchers and their work is, as a matter of fact, a current thing. There is no complex on either side; there is a common language and the financial means. Two-thirds of the budget for research at the Paul Sabatier University comes from contracts for private research.

Seldom, however, has collaboration been as close as between SANOFI [expansion unknown] and the pharmaceutical and toxicological laboratory of CNRS which employs 80 people. Researchers from the two groups have been working together to perfect antitumoral substances. A dozen salaried SANOFI employees have been assigned to the CNRS laboratories. Within the next 2 or 3 years, there will be 20 or 30. It is certainly an interesting formula for training by research; however, SANOFI will profit from previous experiments and from patents taken out jointly. "We know that our research may be marketable," explained Andre Rouquier, assistant director of the CNRS laboratory, "It would be a pity if we didn't follow it out to the end." The appearance of SANOFI in a group in which the State has the larger representation and the motivation of the researchers fighting cancer explains in part this association; however, under the stimulus of Professor Paoletti, its director for the past 8 years, this CNRS laboratory regularly works in concert with industry. "We owe it to the people," Andre Rouquier explains.

Nevertheless, this experience can only be exceptional. "In the field of antitumoral substances, we can work for a long time without finding anything," says Andre Rouquier, "SANOFI understood that it was necessary to invest in the basic research, but we must have sufficient resources to take on such odds."

In other sectors, on the other hand, the small size of a business represents an advantage to the researcher, because reaction is quick in a small business. "Sometimes we have been in competition with large groups," Rene Chelle related, "They were sometimes consulted before we were. When they came back with proposals, we already had built the prototype."

It was the same with Didier Bernadet, P-DG [chairman and managing director] of the Electronics, Information Processing and Systems Company (CEIS), who was also one of "those in the know". "We pay taxes as long as they are good for something." He gets 20 to 30 percent of his sales volume from procedures perfected by government laboratories. His leading product-Argos beacons and ground-satellite receiving stations- was made famous by people who have sailed across the Atlantic.

Sometimes industry does want to come along. Didier Bernadet employs around 60 people and, in collaboration with CNES, has set up with Zodiac a branch to use to advantage the fallout from the Argos and Sargos programs. He still finds time to

direct ADER-MIP, the purpose of which is, in exact terms, to bring industry and researchers together. "To the first I say "Go to it, it's wide open', and to the second I say 'Try to see, in the process, whether it might be of interest to someone'."

Research in Toulouse has not made its full contribution, far from it, to the regional economy. "In the United States the university makes the city and becomes the city's industry; under those circumstances, Toulouse would have 3,000,000 inhabitants," Rene Bernadet said jokingly.

Michele Mourey, project director at ANVAR [National Agency for Improving Research] counted, out of 2,000 PMI in the region, some 60 of them who have frequent contacts with laboratories and, among them, a score created by the researchers themselves. Economic reaction does indeed sometimes exist in the laboratories. And sometimes industry does not want to come along. Thus, ACLAN [expansion unknown], founded in 1977 by five members of the Laboratory for Acoustics and Industrial Measurements of the Paul Sabatier University. "It has been difficult for us to find manufacturers in our acoustical measurement prototypes," explains one of them-Charles Azais. "No one is convinced that there is a future in metrological acoustics. So, we created this company, which is completely independent of the laboratory." Today, ACLAN employs three people and is getting ready to expand so as to put a new apparatus on the market.

Ready to Welcome 21st Century Industry

A high degree of sophistication appears to be the common characteristic in the procedures produced or perfected with the collaboration of government researchers. However, conventional industries are also able to find in the laboratories the improvement in conventional procedures by the introduction of a little science. In this manner, an ovens manufacturer was able to determine the proper placement of the burners by using LAAS calculations [Automation and Systems Analysis Laboratory]. As a result, there was a saving in energy and a reduction in the rate of breakage by thermal shocks. Such examples are rare, perhaps because most of the laboratories in Toulouse have not made provisions for a way to welcome industrialists. The activation of a common bond between organizations will certainly be a more efficient incentive.

This is one of the objectives of the Great Southwest Plan which provides, in addition, for a number of helpful aids to industrial innovation and development. The best opportunities are those which do not yet appear in official booklets but which are developing in the laboratories.

Everything appears to be in place for Toulouse to welcome 21st Century industry. And they want it to happen so much that industry may arrive a few years in advance!

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TRANSPORTATION

BRIEFS

FUEL-SAVING SYSTEM DEVELOPED--Gøtaverken--Svenska Varv [Swedish Shipyards]--has developed a new system for a 6 to 7 percent savings of bunker fuel oil. The system, for that matter, is relatively simple. A saving in the consumption of fuel is achieved by a special patented adjustment of the fuel pump and of the camshafts on the engine. This must be done individually for each engine before departure. The system is to be presented to a number of Norwegian shipowners next week by Ola Jørgensen, Jr., who today owns and operates the Industrial and Marine Consulting Agency in Sweden and England. IMCA markets, for one thing, Unilip in large areas of the world while at the same time the company sells electrohydraulic cranes from Sigval Bergesen, safety valves for central gas works and specially built vacuum cleaners for engine rooms on board. There is certainly considerable interest in Gøtaverken's system here in England and representatives of the shipyard have already sold to British shipowneres. In today's situation in the tanker shipping market all savings are welcome, and especially if it is possible to be somewhat more flexible when it is a question of economical voyages (voyages for fuel). [Text] [Oslo NORGES HANDELS OG SJØFARTSTIDENDE in Norwegian 23 Oct 80 p 7] 8985

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